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YIELD AND RETURNS OF BLUE GUM (EUCALYPTUS) IN CALIFORNIA.

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INTRODUCTION.

Interest in eucalyptus culture is steadily increasing. There is a corresponding demand for information on the yield of plantations as a basis for determining their financial returns. It is the aim of this circular to show what may be expected from blue-gum plantations in California under favorable conditions.

In order to secure reliable figures on the yield of eucalyptus the Forest Service, in cooperation with the California State Board of Forestry, measured in 1910 a large number of the most successful eucalyptus plantations in California. Most of these measurements were of blue gum (*Eucalyptus globulus*), the species most extensively planted. Of the many species of eucalyptus it is the one which seems best adapted to California conditions, and it is also one of the most rapid growing. The results of this work have been published in Bulletin 1, California State Board of Forestry, under the title "Yield from Eucalyptus Plantations in California," which may be obtained without cost from the State Forester, Sacramento, or from the Forest Service, San Francisco. The best figures obtained in this study, together with known costs of establishing and caring for plantations, are here summarized.

COST OF ESTABLISHING PLANTATIONS.

The first item to be reckoned with in the establishment of a plantation is the cost of land. The better the land the more satisfactory, up to a certain point, will be the returns. Good irrigable land near transportation, however, is in great demand for the raising of farm crops, and its price is correspondingly high. Moreover, such land yields large annual returns under diversified crops, and its most profitable use is not the growing of trees. Stiff, heavy, loamy or sandy, nonirrigable lands free from hardpan, such as are suitable for grain farming, with a water table not more than 12 feet below the surface, are usually well adapted to blue gum. Such areas in desirable localities, that is, near transportation and where the mini-

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mum temperature is not less than 24° F., can be purchased for about $30 per acre.

The cost of preparing an acre of ground for planting does not ordinarily exceed $6. Seedlings can be purchased for $6 per thousand. The planting of 1,000 trees (enough for an acre) costs about $4. The cost of cultivating and caring for a plantation for two years does not usually exceed $7 per acre, including the purchase of trees to fill blanks in the plantation. Any thinnings made up to the time of the first cutting should pay for themselves. The cost of establishing a plantation and carrying it through the first two years, excluding the cost of land, is therefore about $23 per acre.

Taxes on the class of land used for growing blue gum amount to about 30 cents per acre per year. Ten cents per acre per year should be expended in protection from fire. These two items represent a fixed annual charge per acre for the 10-year period before the first cutting. Discounted at 4 per cent, this amounts to a present investment of about $3.25 per acre.[1] The total investment involved in establishing 1 acre of plantation is, therefore, about $56.25.

YIELDS OF PLANTATIONS.

Actual measurements show that an average annual yield of about 6.4 standard cords, or 8.5 California cords, per acre is produced by the best blue-gum groves in the State.[2] This figure was obtained by finding the mean annual growth per acre of all the groves examined in 1910 which contained over 5 standard cords, and then determining the average of 20 per cent of the groves showing the most rapid mean annual growth.[3] It was thus based upon the best 5 of the 25 groves examined. While not strictly accurate, since the rate of growth of trees varies somewhat at different ages, it is sufficiently so for practical purposes in this instance, where the range in ages is not great. Individual groves have occasionally done better. One grove was found which produced 185.9 standard cords in 25 years, or about 7.4 cords per year. Another produced over 59 cords in nine years, or nearly 6.6 cords per year. On the other hand, three groves under average conditions, with fair soil and the water

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[1] This is derived from the formula giving the present value of an amount spent annually for a given number of years, $E=\frac{r\ (1.0\ p^n-1)}{(1.0\ p^n \times .\ op.)}$, in which E=present value of the charges for taxes and protection; r=annual tax and protection charge ($0.40); p=rate of interest (4 per cent); and n=number of years (10). The present value of the charges for taxes and protection is the amount which, invested at the given rate of interest, will meet these charges annually, and will be exhausted at the end of the period.

[2] A standard cord contains 128 cubic feet of stacked wood, or approximately 90 cubic feet of solid wood; a California cord, the local unit, is three-fourths of a standard cord and consequently contains 96 cubic feet of stacked wood, or approximately 67.5 cubic feet of solid wood.

[3] Bulletin 1, California State Board of Forestry, pp. 12–14.

table not more than 25 feet from the surface, show an annual growth per acre of only 4.05, 3.9, and 3.7 cords, respectively. Under unfavorable conditions, with a deep water table or with hardpan near the surface, the annual growth in two cases has been as low as 1.6 cords and 1.1 cords per acre. An annual yield of 6.4 cords per acre, or 64 cords per acre in 10 years, may therefore be accepted as a fair estimate of what may be obtained upon the best sites under the methods of management heretofore used.

Assuming a stumpage price of $2.50 per standard cord, this yield would return $160 in 10 years from the wood alone. This represents nearly 13 per cent compound interest on the original investment of $56.25.[1] Out of that amount $30, the cost of the land, may be considered as restored to the investor with the harvesting of the crop, and is in effect an additional return.

Since blue gum sprouts rapidly, the same return of 64 cords, worth $160, should be obtained periodically at the end of every 10 years for at least several rotations. In this case, however, no additional expenditure is necessary for establishing or caring for the plantation. The amount invested is, therefore, $33.25 ($30 for land and $3.25 for capitalized taxes and protection). A return of slightly more than 19 per cent would thus be realized in growing each of the sprout crops following the first, or planted crop. This is assuming that the value of the land remains unchanged and that this amount is reinvested periodically after each crop is harvested.

In the figures just given it is assumed also that the operation is handled by the individual investor on an area large enough to be managed economically. This should be not less than 50 acres.

The greatest yield of any blue-gum grove measured by the Forest Service was found in a plantation 32 years old. This stand contains 57,820 board feet of timber per acre, measured by the Scribner Decimal C log rule, besides 30.9 standard cords (41.2 California cords) of wood to be cut from tops too small for lumber. Assuming a stumpage rate of $5 per thousand feet for lumber and $2.50 per standard cord, the return on this grove would amount to $366.35 per acre for the 32-year period. If it costs $60.15 per acre (on the same basis as that used above) to buy and plant the land, care for the young trees two years, and pay taxes and protection charges 32 years (discounted to the present at 4 per cent), the return is a little over 6 per cent com-

[1] This is derived from the well-known valuation formula $Y=(C+E)\times 1.0p^n+S(1.0p^n-1)$, in which Y=yield at end of rotation ($160); C=cost of establishing and caring for plantation ($23); E=capitalized expenses for taxes and protection ($3.25); S=cost of land ($30); n=length of rotation (10 years); and p=rate of interest. The -1 in the formula is due to the fact that the value of the land at the end of the rotation is assumed to be the same as at the beginning, so that interest alone is lost on the money invested in land.

pounded.[1] If the stumpage values are $10 for saw timber and $2.50 for cordwood the return per acre would amount to $655.45, or nearly 8 per cent on the same investment.

A grove in Alameda County shows a yield of 54,200 board feet of timber and 43.3 standard cords (57.8 California cords) per acre in 25 years. Assuming a stumpage rate of $5 per thousand for the timber and $2.50 per standard cord for the wood, the return from this grove would be $379.25 per acre for the 25-year period,[2] the cost of land, planting, etc., being figured as before. This would net about 8 per cent compounded. If the stumpage price is $10 per thousand for saw timber and $2.50 per cord for the limb wood, the return per acre would amount to $650.25, a little over 10 per cent on the investment.

The stumpage figures used are mere assumptions. It is probable that but a small part of the timber produced in any of these groves could be sold for lumber at the present time. Most of the trees are between 10 and 12 inches in diameter at 4½ feet from the ground. There is as yet but little demand for eucalyptus of such small dimensions for manufacture into lumber.

Of California eucalyptus as lumber little is known. Up to the present time but small quantities have been manufactured. A few well-developed old trees, which have grown in the open and are unusually large, are sold for high prices. No sales of entire groves for lumber have been made, however, since most of the trees are still too small or too crooked and limby to be sawed at a profit. In Australia no eucalyptus goes into the sawmill from trees less than 30 years old or 2 feet in diameter, since lumber from young trees warps and shrinks badly, resulting in great waste.[3]

In every young grove, however, a number of trees have outstripped their neighbors in form and size. In the management of a plantation it will probably be found profitable to cut the less desirable trees for cordwood at the end of about 10 years, leaving from 150 to 200 of the best trees on each acre to grow to saw-timber size, at 30 or 40 years. In that form they should bring a larger return per unit of volume than as cordwood. Moreover, as the problem of seasoning small California-grown eucalyptus is worked out, and as manufacturers become more familiar with the handling of this wood, a demand for it will arise and doubtless lead to the establishment of more definite stumpage values. Investigations by the Forest Service to determine the best method of seasoning blue gum by kiln drying were completed and will soon be published.

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[1] See footnote on p. 5. The costs for land and for establishment and care of the plantation are the same as before, but the present value of taxes and fire protection is $7.15 on account of the longer period.

[2] See footnote on p. 5. In this case the present value of taxes and fire protection amounts to $6.25.

[3] Forest Service Circular 179, p. 28.

WHAT RETURNS CAN BE EXPECTED UNDER MOST FAVORABLE CONDITIONS.

Much greater yields and higher financial returns have been claimed for eucalyptus plantations by commercial companies which are exploiting them. Planted land has been offered in many instances as a desirable investment at as much as $250 per acre. It has been asserted that an acre of planted eucalyptus will produce 100,000 board feet of lumber in 10 years.

Measurements of existing groves by the Forest Service show, however, that the best return per acre which can be expected from a 10-year plantation of blue gum, under present conditions, is approximately $160. If the original investment does not exceed $60, including taxes and protection, until the crop is cut this return is satisfactory. If the investment is greater than $60 per acre, on account of planting higher-priced land or for other reasons, the returns are correspondingly reduced. If the total amount paid out exceeds $160 per acre, obviously there is a loss of capital aside from the failure to secure any interest upon it.

These measurements show, furthermore, that the best blue-gum groves in California have yielded but 64 standard cords (85 California cords) per acre in 10 years. The yield must be given in cordwood rather than in board feet of lumber. The trees in these plantations have attained an average diameter of from 9 to 10 inches outside the bark at 4.5 feet above the ground. Since the bark is 0.75 of an inch thick, about 1.5 inches must be deducted from the diameter to obtain the net yield of wood. The taper of blue-gum logs, determined by actual measurements, is 0.163 of an inch per foot. The top diameter of a log 12 feet long and 10 inches in diameter outside the bark at 4.5 feet above the ground (allowing 12 inches for the height of the stump) is 7.12 inches inside the bark. Such a log, when measured by the Scribner Decimal C rule, scales 20 board feet. It has been found that young timber of this character shrinks about 14 per cent in seasoning to an air-dry condition, and that the wood contains loose knots left by the branches. From this it is apparent that only small timbers suitable for short-length flooring, chair legs, handles, etc., can be obtained from trees of this size. Such trees can hardly be considered as merchantable for manufacture. The chief product of a 10-year eucalyptus grove, therefore, is not lumber but cordwood.

The best 32-year-old plantation in the State scales but 57,820 board feet and 30.9 cords per acre. It is true that none of the older groves in California have been properly thinned or otherwise cared for, and that better management undoubtedly will increase the yield, at least of saw timber. To what extent such management will increase the total yield of plantations has not been demonstrated and can be worked out only by experience. It should be borne in mind,

however, that nowhere in the history of the world has any such quantity of wood as 100,000 board feet been produced per acre in 10 years. There is a limit to the productiveness of even the best land under the best conditions of management. This limit, as far as intensive forest culture has yet demonstrated, is far below 100,000 board feet in a decade. Barring redwood, bigtree, Pacific coast Douglas fir, and virgin stands of eucalyptus in Australia, it is but rarely that forests anywhere produce this quantity of material per acre in one crop, regardless of the element of time.

The investigations made by the Forest Service indicate, therefore, that returns from blue-gum plantations are satisfactory if the total investment is $60 an acre or less; that in proportion as the initial investment and discounted carrying charge exceed this amount, the prospects of a good profit are reduced, and that an investment approaching $160 per acre can not be expected to pay back more than the bare principal. Satisfactory results can ordinarily be secured by personally starting and caring for plantations rather than by purchasing planted land at any figure which is out of proportion to the actual cost of establishing the crop.

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